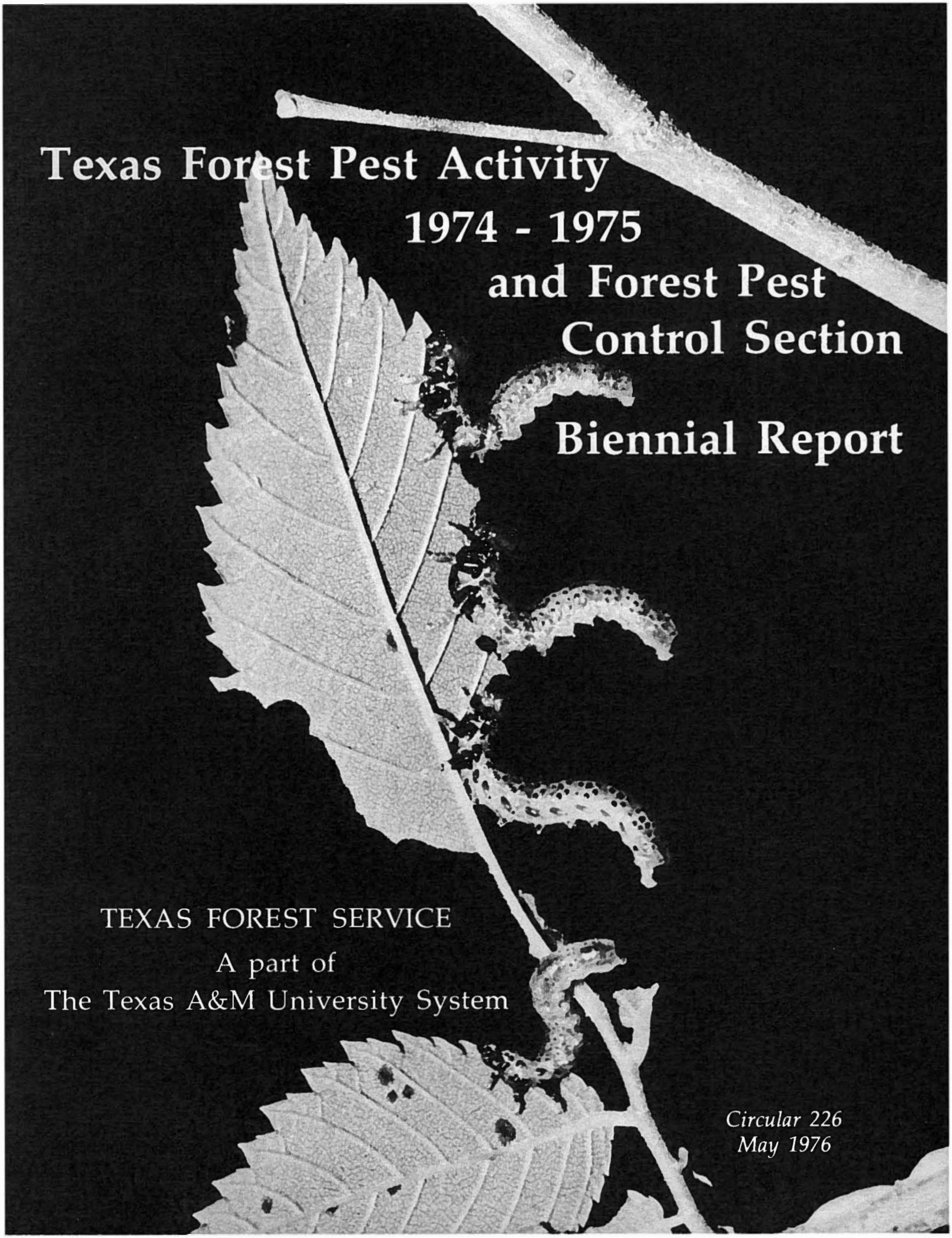


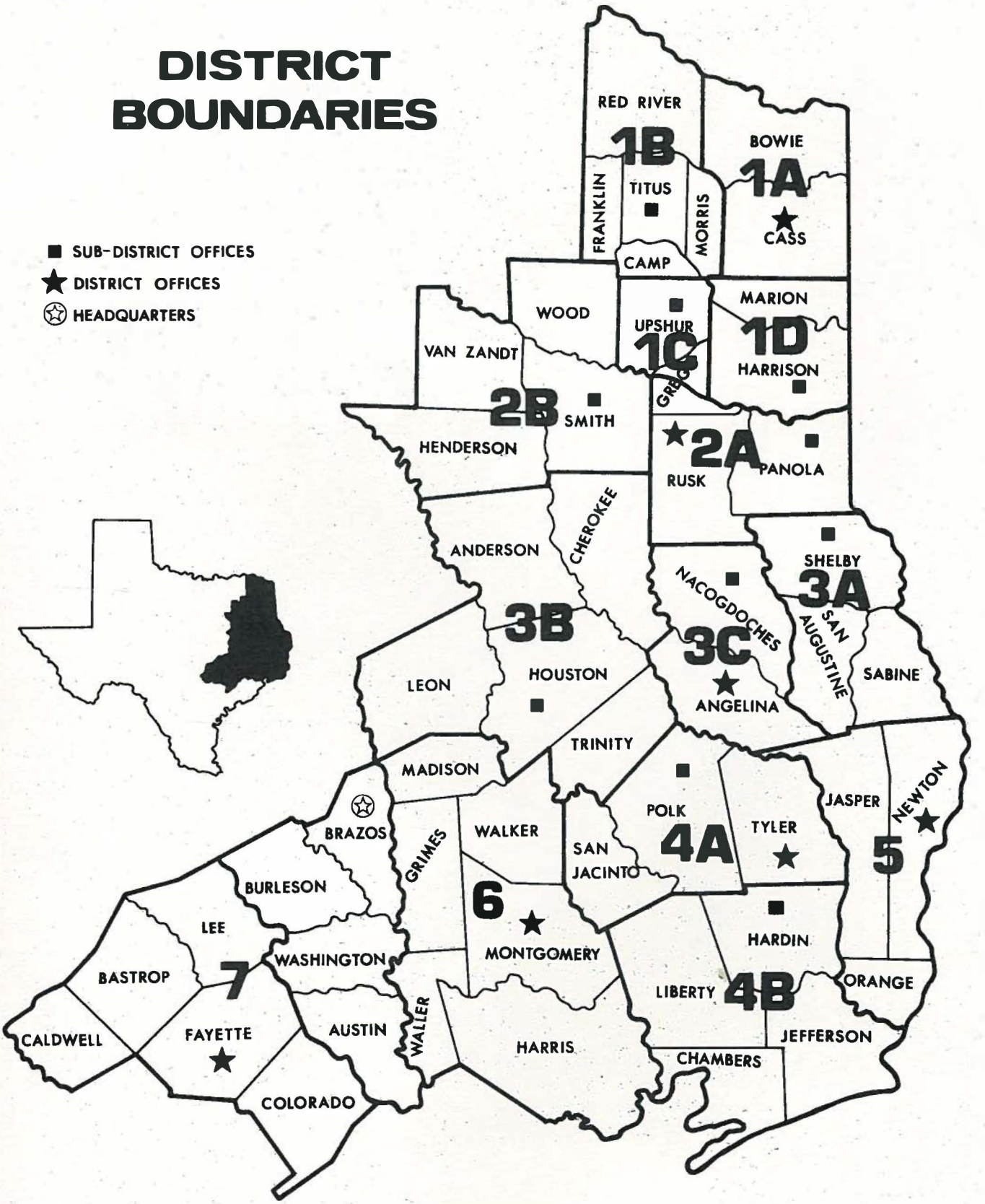
Texas Forest Pest Activity 1974 - 1975 and Forest Pest Control Section Biennial Report

TEXAS FOREST SERVICE
A part of
The Texas A&M University System

Circular 226
May 1976

TEXAS FOREST SERVICE

DISTRICT BOUNDARIES



Texas Forest Pest Activity 1974 - 1975 and Forest Pest Control Section Biennial Report

Private Forest Industry
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Introduction

The Forest Pest Activity Report has been published since 1967 by the Texas Forest Service Pest Control Section to summarize losses caused by forest pests and to serve as a historical record of insect and disease activity in the commercial forest of Texas. In 1974, this circular was expanded to include a biennial synopsis of research activities, personnel changes and recent developments concerning the Pest Control Section.

Texas Forest Pest Activity 1974-1975

Southern Pine Beetle

The current outbreak of the southern pine beetle, *Dendroctonus frontalis,* which began in 1958, continued unabated during 1974 and 1975. Of all the potential forest pests native to Texas, this bark beetle caused the greatest losses to pine forest resources, not only in this state but also across the South.

Southwide SPB Infestation Status

According to a recent U. S. Forest Service report[1], the southern pine beetle (SPB) remains active over 46.7 million acres, or approximately 47 per cent of the susceptible host type in the southern U. S. Most of the twelve states involved in the outbreak reported mixed activity, with improved conditions in some areas and moderate or increasing beetle populations in other areas. Substantial reductions in beetle activity were reported in 1975 in Alabama, Georgia, South Carolina and Mississippi, while infestations have increased most in Texas and Tennessee. Florida and Kentucky reported beetle infestations for the first time during the current outbreak.

During Fiscal Year 1974 a total of 51,283,000 cubic feet of beetle-killed timber was salvaged; in Fiscal Year 1975 this total increased to 64,396,000 cubic feet. In contrast, the federal funds expended for beetle control decreased from $1,546,429 in Fiscal Year 1974 to $1,315,181 in Fiscal Year 1975. Unfortunately, not all trees killed by SPB are harvested, and as a result the total impact of this pest is only partially reflected by these salvage figures.

[1]Southeastern Area Southern Pine Beetle Outbreak Status — July, 1975. U.S. Forest Service State and Private Forestry, Atlanta, Georgia (Unpublished report).

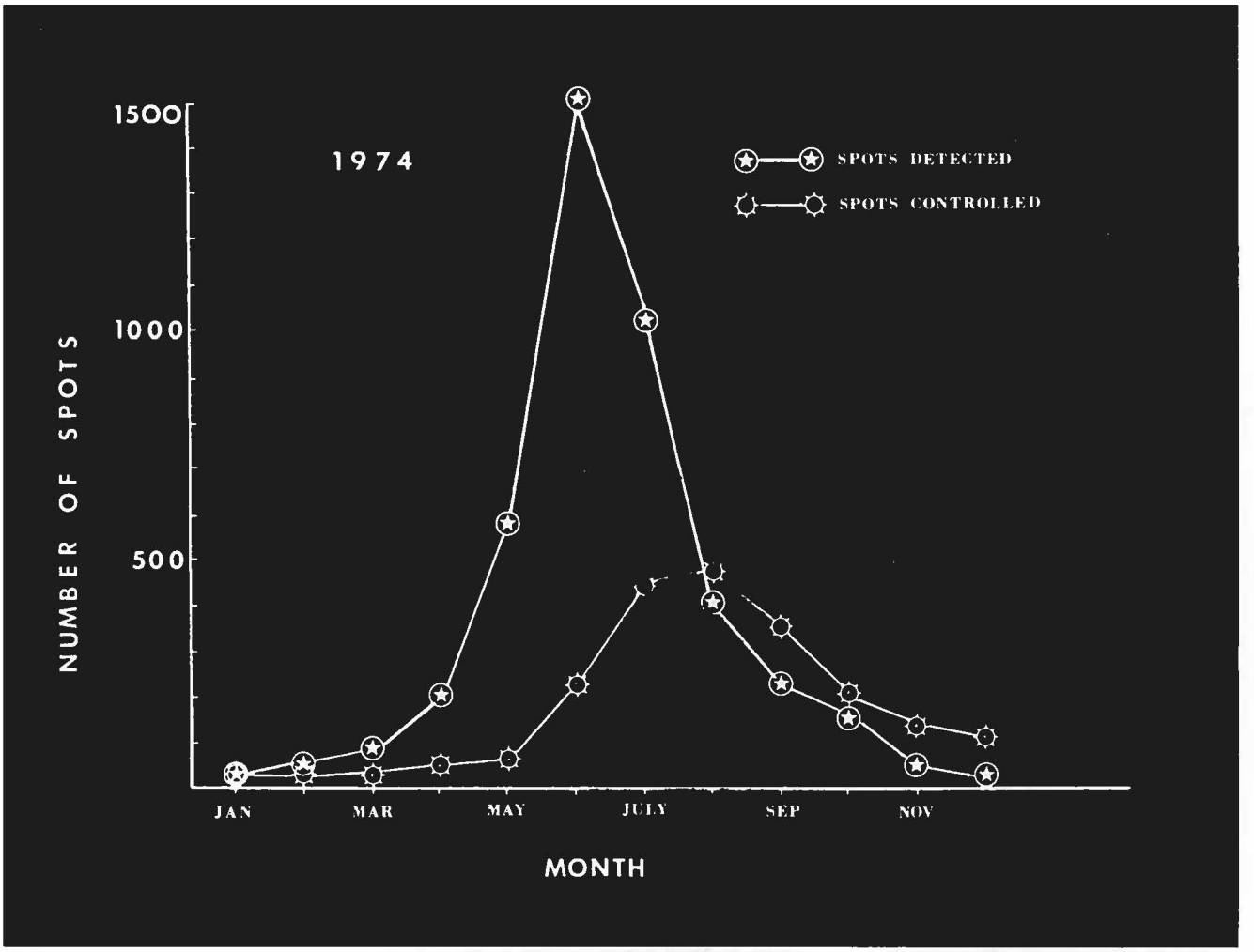
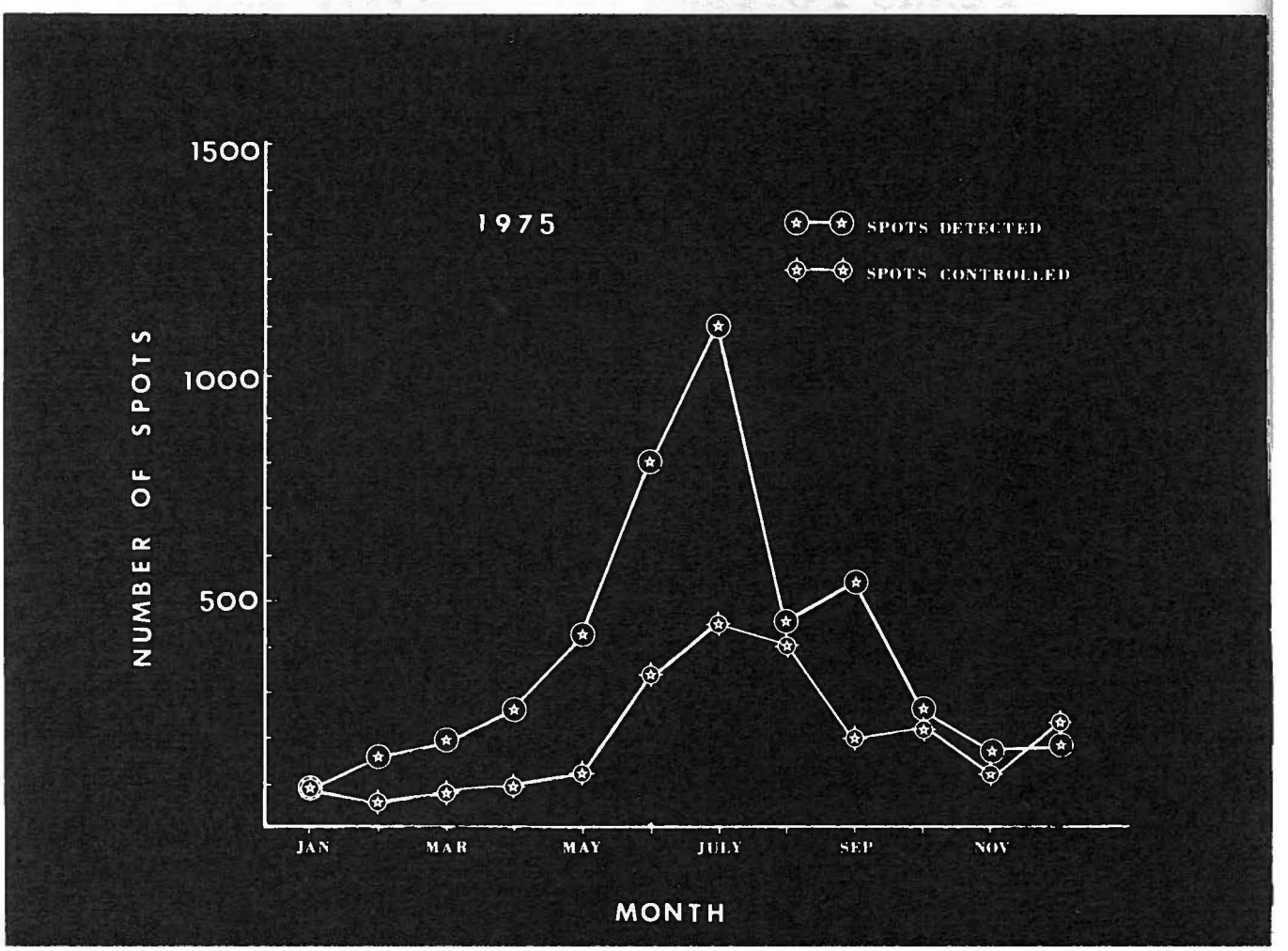


Figure 1. Monthly Patterns of SPB Detection and Control in East Texas During 1974 and 1975.



SPB in East Texas 1974-1975

The SPB Operations Informational System was initiated by the Texas Forest Service in 1973 to facilitate statewide detection, ground check and control operations.[2] In addition, this computerized record-keeping system conveniently generates summaries of SPB activity and associated timber losses. Information collected in the field on individual spots (multiple tree infestations) was expanded in 1974 to include timber losses by cubic foot volumes of pulpwood and sawtimber, total merchantable and non-merchantable trees killed, and acres infested. Specific loss figures were obtained on 56 per cent and 71 per cent of all spots detected throughout the state in 1974 and 1975, respectively. As a result of these improved data collection procedures, the volume estimates for 1974 and 1975 no doubt more accurately reflect actual losses than do estimates for previous years, which were based on a much smaller sample.

The total number of spots reported from aerial detection flights provides a gross measure of the magnitude and annual variation of SPB activity (Table 1). In interpreting these figures, it should be noted that the minimum spot size (number of active trees) for aerial detection was increased from 5 to 10 trees beginning in 1974. This decision no doubt reduced the annual detection figures since many small spots are not presently recorded.

These data indicate that beetle activity has remained at high levels during the past two years. In 1974, 4,279 new spots were detected, of which 49 per cent were controlled and 39 per cent were reported inactive prior to the end of the year. The remaining 12 per cent consisted of spots that were never ground checked or active spots that were carried over into Calendar Year 1975 (1974-1975 carryovers = 242 spots).

By comparison, in 1975, 4,672 new spots were detected, of which 52 per cent were controlled and 32 per cent went inactive before the end of the year. Only 127 active spots were considered as carryovers into Calendar Year 1976.

Figure 1 illustrates the monthly patterns of spot detection and control activities. The frequency of new spot detection was greatest during the month of June in 1974, while in 1975 most spots were detected in July, due to retarded foliage fade. This graph represents rate of detection of infestations having at least 10 active (brood) trees. Since aerial detection is based on observing the fading foliage of attacked trees, the curve does not necessarily represent seasonal trends in beetle activity *per se*. Beetles are active whenever air temperatures exceed approximately 60° F and thus may be capable of infesting trees during all months of the year. Peak beetle activity probably occurs during the late spring and early fall, when optimal environmental conditions prevail.

A summary of 1974 and 1975 beetle infestation levels by county is given in Appendices I and II. The ten counties most heavily infested during 1974, listed in decreasing order of magnitude, were Montgomery, Walker, Angelina, Hardin, Liberty, Houston, Trinity, Jasper, Polk and Tyler. In 1975, the beetle population decreased substantially in Texas Forest Service Districts 6 (Conroe) and 3 (Lufkin) and increased in Districts 4 (Woodville) and 5 (Kirbyville), the area of chronic infestation. A reference map of Texas Forest Service administrative boundaries is included on the inside front cover. This shift in beetle activity is reflected in the county summaries for 1975; the most heavily infested counties were Hardin, Liberty, Jasper, Polk and San Jacinto followed by Angelina, Montgomery, Tyler, Houston and Trinity. For the first time since the current outbreak began, SPB infestations were detected in Harrison and Upshur counties during 1975.

Estimates of the total volume of pine timber killed by the southern pine beetle in East Texas from 1958 through 1975 are listed in Table 2. Although the total number of spots detected increased from 1974 to 1975, the total volume of pine timber killed by the beetle in East Texas declined by approximately 20 per cent in 1975, indicating a reduced average volume of timber per spot.

Table 1. SPB Spots Detected by Aerial Sketch Mapping Since 1970.

Year	Total New Spots Detected
1970	867
1971	1,376
1972	5,190
1973	3,853
1974	4,279*
1975	4,672*

*Minimum spot size increased from 5 to 10 brood trees

[2]For a more detailed description of the Operations Informational System, see 1972-1973 Texas Forest Pest Activity and Forest Pest Control Section Annual Report. TFS Circular 219 (1974).

Table 2. Estimated Volume of Pine Timber Killed by the Southern Pine Beetle in East Texas Since 1958.

Year	Sawlogs	Pulpwood	Total
	M bd. ft.	cords	M cu. ft.
1958	500	0	84
1959	2,500	2,500	598
1960	8,000	8,000	1,912
1961	17,887	24,000	4,715
1962	93,043	111,110	23,538
1963	4,084	1,920	820
1964	2,501	1,420	520
1965	3,797	7,743	1,192
1966	6,256	6,930	1,544
1967	7,194	8,566	1,818
1968	17,644	22,037	4,533
1969	7,341	7,478	1,760
1970	4,318	14,730	1,782
1971	3,872	66,933	5,466
1972	24,710	50,393	7,755
1973	38,595	45,983	9,900
1974*	50,489	52,622	12,383
1975**	45,187	32,987	9,951
Total	337,918	464,452	90,271

*Estimates based on individual tally of 56% of all spots detected.

**Estimates based on individual tally of 71% of all spots detected.

Table 3. 1974 & 1975 Losses from Southern Pine Beetle — Texas State Totals.*

	1974	1975
Acres of Kill	7,049	8,423
Number of Trees Killed	650,520	635,753
Merchantable	579,760	564,640
Non-Merchantable	70,760	71,113
Total Volume (Cubic Feet) Killed	12,382,570	9,950,563
Sawlogs	8,414,890	7,531,236
Pulpwood	3,967,680	2,419,327
Total Volume of Killed Timber Salvaged	7,031,960	3,429,941
Sawlogs — cu. ft.	4,673,800	2,487,630
Pulpwood — cu. ft.	2,358,160	942,311
Total Volume of Killed Timber Not Salvaged	5,350,610	6,520,622
Sawlogs — cu. ft.	3,741,090	5,043,606
Pulpwood — cu. ft.	1,609,520	1,477,016
Estimated Dollars of Resource Lost** (Direct Cost of Stumpage Only)	$ 2,395,000	$3,179,000

*Includes USFS.

**Based on following loss estimates: $4 per cord for salvaged pulpwood, $6 per cord for non-salvaged pulpwood, $40 per MBF for salvaged sawtimber, $80 per MBF for non-salvaged sawtimber.

Table 4. Summary of Statewide SPB Control Efforts — 1974 & 1975.

Year	Type of Control	TFS District 3	4	5	6	Total	Percent of Total Controlled
1974	Salvage	437	249	109	531	1,326	64
	Cut and Leave	182	157	62	71	472	23
	Cut and Top	6	105	13	15	139	7
	Insecticide (BHC)	5	11	7	1	24	1
	Combination	48	60	9	8	125	6
	Total Control	678	582	200	626	2,086	100
	Total Inactive	666	356	72	574	1,668	
1975	Salvage	434	323	86	65	908	36
	Cut and Leave	276	761	216	83	1,336	52
	Cut and Top	3	24	26	13	66	3
	Insecticide (BHC)	5	30	10	11	56	2
	Combination	45	99	30	9	183	7
	Total Control	793	1,275	373	182	2,549	100
	Total Inactive	476	583	244	334	1,637	

A more detailed account of 1974 and 1975 losses from SPB is listed in Table 3. The estimated value of pine resources lost to beetle activity increased from $2,395,000 to $3,179,000, based on direct cost of stumpage only. This substantial increase in dollar loss reflects the fact that only approximately 35 per cent of the total volume killed by SPB was salvaged in 1975, compared to 57 per cent the previous year.

SPB Control Program

Since early 1969, when large-scale use of the insecticide benzenehexachloride (BHC) was discontinued in East Texas, control action against the southern pine beetle has been aimed at minimizing timber losses rather than eradication of the beetle. Salvage and prompt timber utilization continues to be the preferred tactic for accomplishing this goal. As shown in Table 4, salvage was the most frequently applied control method in 1974, accounting for 64 per cent of the statewide control effort. The most common alternative to salvage in 1974 was "cut and leave," a tactic designed to reduce potential timber losses by disrupting spot growth. The average time lapse between detection and control in 1974 was 53 days.

In 1975, "cut and leave" surpassed salvage as the principal means of control in Districts 4, 5 and 6 (Table 4). The reduction in salvage operations is attributed to a combination of high rainfall, which hindered access, and poor markets for beetle-killed timber. The average time lapse between detection and control in 1975 was 35 days.

Computer Generated Maps of Annual SPB Activity

In 1974, the Texas Water Development Board generated a computer plot of Texas Forest Service data showing the geographical distribution of SPB infestations throughout the state. The computerized detection and control records of the Operations Informational System provide the data from which these maps are derived. The same computer program can be used at the end of each year to generate a new map of detection and control records at a nominal cost. The 1974 and 1975 infestations are shown in Figures 2 and 3.

These maps have proven useful for illustrating the statewide distribution of SPB activity and to quickly communicate the seriousness of the problem to persons unfamiliar with this pest. Furthermore, a comparison of computer maps for several consecutive years provides a visual documentation of the extent with which beetle activity shifts geographically from one year to the next. In all, the computer maps provide a dynamic perspective to the SPB problem that was unavailable prior to the Operations Informational System.

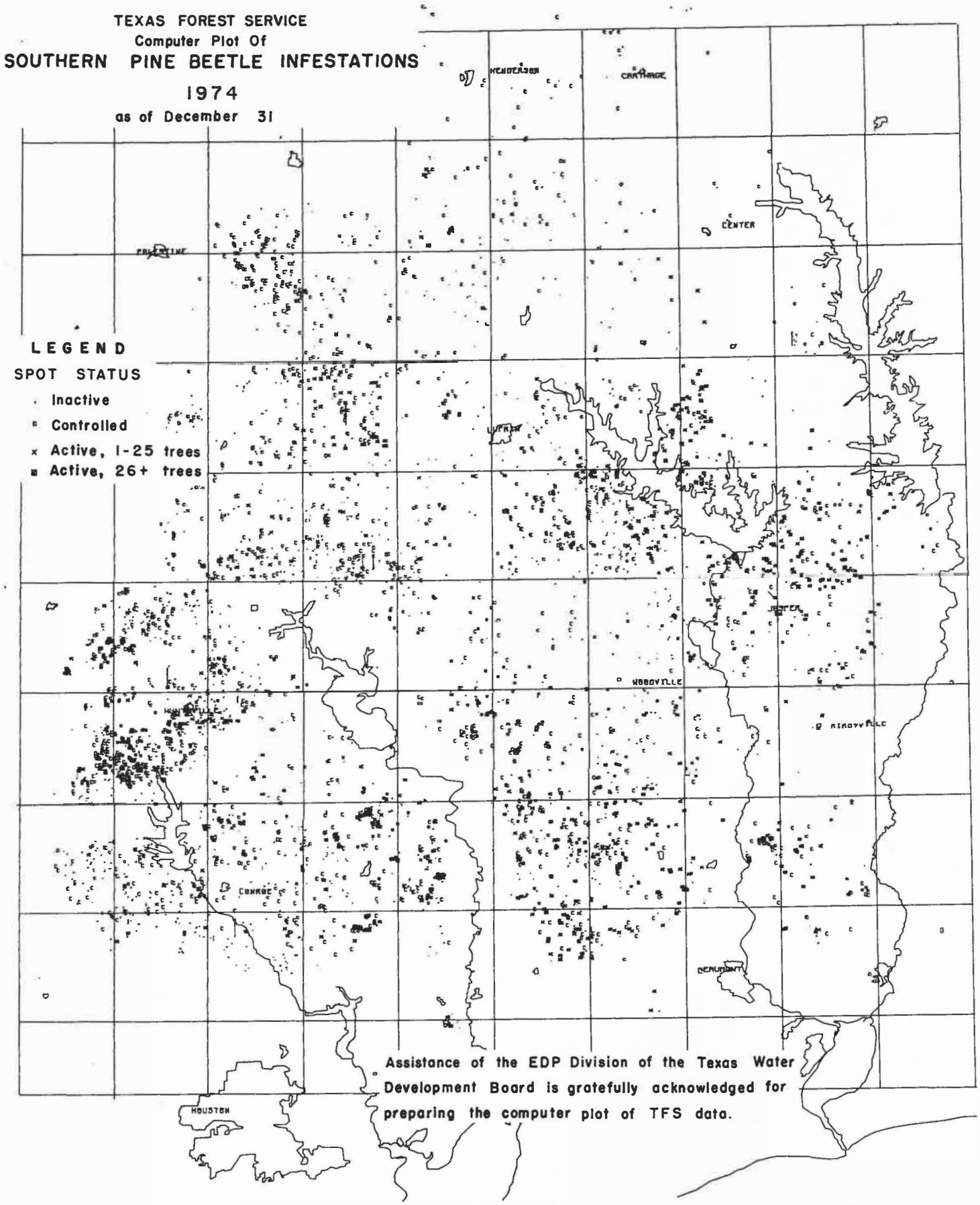


Figure 2. SPB Infestations in East Texas at the End of 1974 Season.

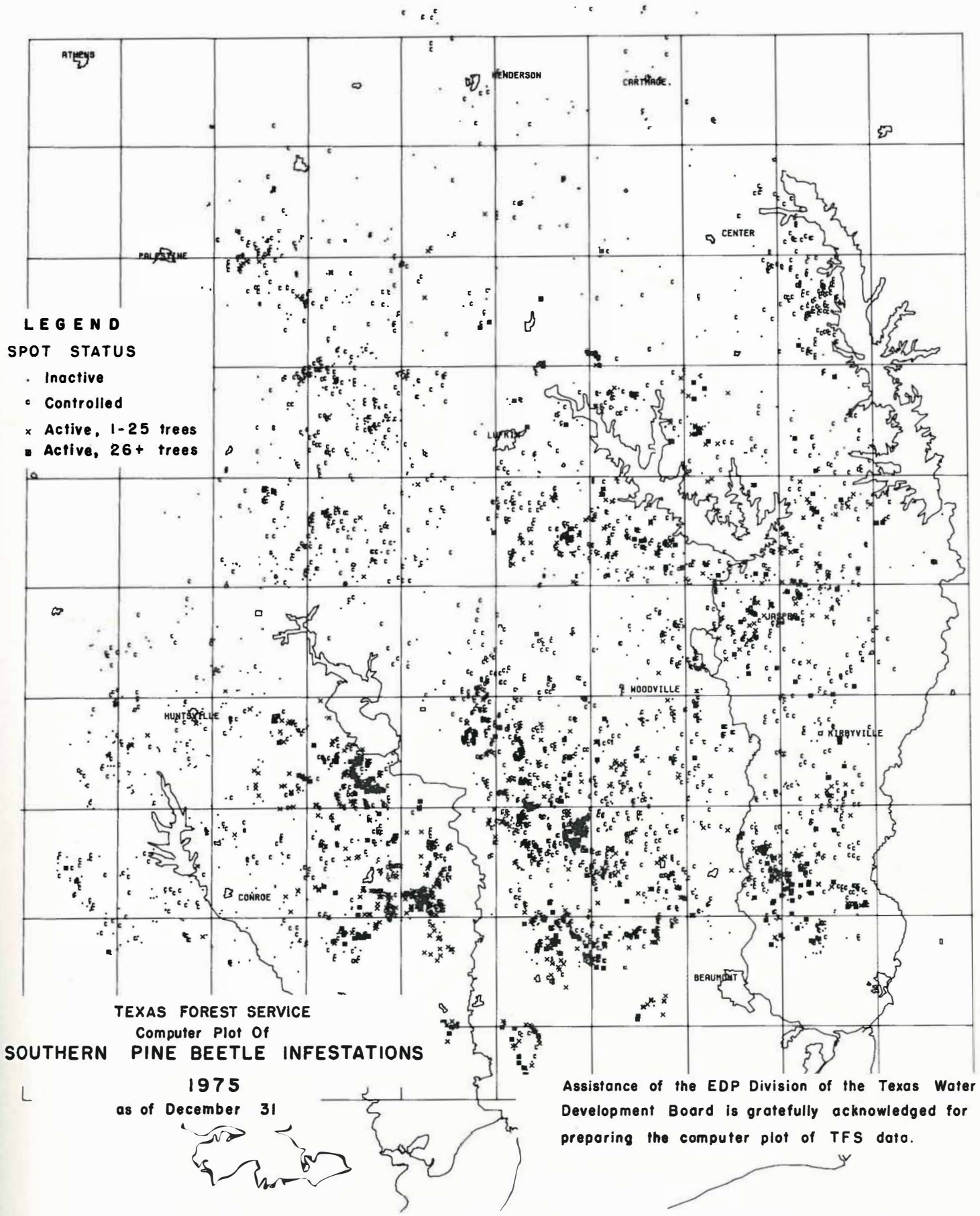


Figure 3. SPB Infestations in East Texas at the End of 1975 Season.

Other Bark Beetles

Other bark beetle pests native to East Texas pine forests include the black turpentine beetle (BTB), *Dendroctonus terebrans,* and three species of engraver beetles, *Ips calligraphus, I. grandicollis* and *I. avulsus.* These bark beetles are commonly found in association with SPB. Abnormally high activity of BTB was reported in 1974 and 1975 in Harrison, Marion, Walker, Trinity, Hardin and Liberty counties while *Ips* damage was recorded in Harrison, Marion, Walker, Rusk, Hardin, Liberty, Houston, Cherokee and Anderson counties. The recommended control for both *Ips* and *BTB* in commercial forests is prompt salvage of infested trees. trees.

Defoliators

Texas leaf cutting ants or town ants, *Atta texana,* were reported to have defoliated seedlings during 1974 in Walker, Jasper, Tyler, Newton, Hardin and Panola counties and in 1975 in Panola, Harrison, Nacogdoches, Jasper, Newton, Hardin, Tyler and Waller counties. Mirex bait was used in most cases to reduce colonies in newly planted areas. No unusual lepidoteran defoliator populations were observed. Large numbers of the pine colaspis beetle, *Colaspis pini,* were found defoliating loblolly pines in areas near Lufkin in July, 1975. An infestation of the red-headed pine sawfly, *Neodiprion lecontei,* was reported on 400 acres of pine plantations in San Jacinto County in 1975. No other reports of this insect were received.

Tip Moths

Some 400 acres of pine in Harrison and Marion counties were infested with the Nantucket pine tip moth, *Rhyacionia frustrana,* during 1975.

Forest Diseases

The only "disease" creating alarm during 1974 and 1975 was that which caused a large number of red oaks to die abruptly throughout East Texas. The problem was of particular concern to homeowners who lost valued shade trees. No infectious pathogen nor insect was identified as the causal agent. The most accepted explanation was that death resulted from abruptly changing soil moisture conditions which, in turn, destroyed a large proportion of the root hairs. The return of more normal rainfall patterns has greatly reduced the mortality of red oaks.

Of the common infectious diseases of commercial pine forests, fusiform rust, *Cronartium fusiforme,* was observed in Harrison, Marion, Newton and Harris counties and pine needle cast, caused principally by *Hypoderma lethale,* was very widespread throughout East Texas in 1975. *Fomes annosus* root rot was reported affecting pine stands in Nacogdoches, Newton, San Augustine and Cherokee counties.

Recent Developments and Research Progress

Research Projects

Traditionally, the primary responsibility of the Forest Pest Control Section has been to provide supervision, guidance and training to Texas Forest Service District personnel concerning all pest-related problems. With the recent additions to the Pest Control staff, however, activities have been expanded to include active research programs in two problem areas: seed orchard pests and the southern pine beetle. In both cases, the research is oriented towards solving pest-related problems faced by forest managers rather than solely dedicated to the accummulation of basic scientific knowledge. Synopses of the research projects now underway and the preliminary findings are presented below.

Cone and Seed Pest Research

A female pine flower requires approximately 18 months to develop into a cone with mature seeds. This extended developmental period exposes the cones to damage by various types of destructive organisms. Insects, particularly coneworms, seedworms and seedbugs, represent one of the major causes of damage to developing cones and seeds in southern pine seed orchards. Coneworms, *Dioryctria* spp., often damage up to 25 per cent of the second year cone crop. Seedworms, *Laspeyresia* spp., sometimes destroy up to 40 per cent of the longleaf seed crop, but usually cause only minor damage to the seeds of other southern pine species. On the other hand, the two common species of seedbugs, *Leptoglossus corculus* and *Tetyra bipunctata,* (Figures 4, 5) often reduce the number of filled seeds per cone by as much as 50 per cent. All southern pine species grown in seed orchards are susceptible to seedbug damage.

Since 1972, the Pest Control Section has been conducting a research program on seed orchard insects directed toward identifying and measuring the impact of the various destructive agents and evaluating chemicals for suppression of the most important pests.

Cooperative Impact Study. The Texas Forest Service is cooperating in a south-wide effort to monitor losses caused by insects throughout seed development and germination. The loblolly pine

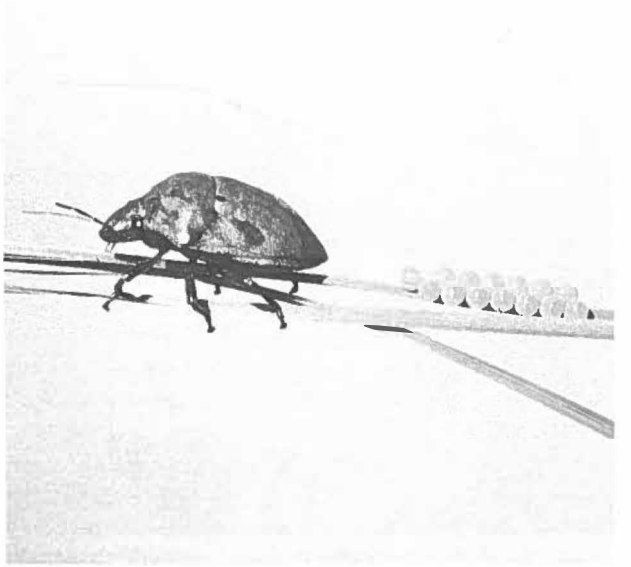


Figure 4. Adult and eggs of the shieldback pine seedbug, *Tetyra bipunctata,* on pine needles.

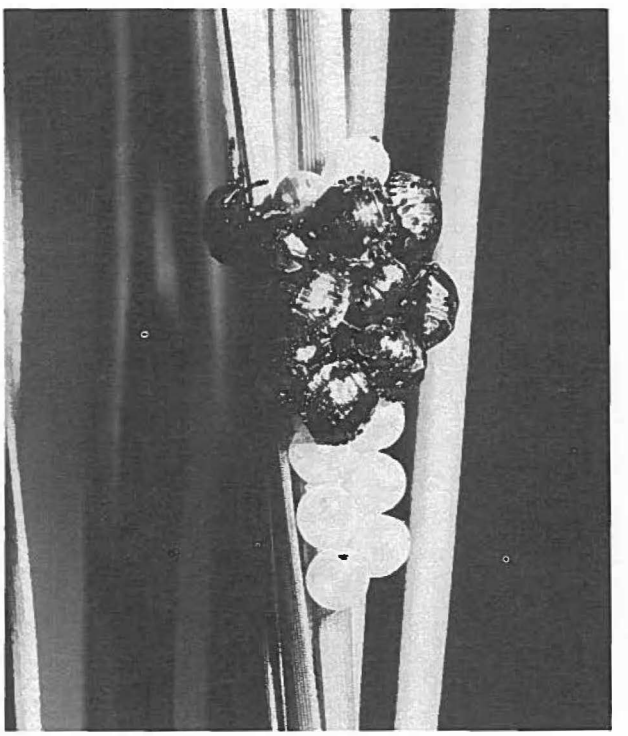


Figure 5. Nymphs emerging from eggs of the shieldback pine seedbug, *Tetyra bipunctata,* an important pest of southern pine seed orchards.



Figure 6. A portion of the conelets in the high-density loblolly seed orchard at Magnolia Springs were tagged and periodically monitored throughout development to ascertain the extent and nature of damage.



Figure 7. At maturity, tagged cones were harvested individually and taken to the lab for drying and seed extraction.



Figure 8. After extraction from the cones, seeds were x-rayed to determine the extent of seedbug damage and the proportions of empty and full seed.



Figure 9. Finally, seeds from each cone were germinated in individual containers to determine the proportion of viable seed.

seed orchard at Magnolia Springs was selected along with orchards in six other locations throughout the South for this study. Beginning in the spring of 1974, sample conelets were tagged on 40 trees and inspected periodically until cone harvest in October, 1975 (Figures 6, 7). Ten per cent of the 1975 conelets on the same trees were tagged and will be monitored monthly until cone harvest in 1976. The 1975 cones were harvested individually and the seeds were extracted, x-rayed to determine the per cent of empty seeds, and germinated to determine the per cent germination (Figures 8, 9). Thus, conelet, cone and seed mortality in the absence of chemical control can be accurately estimated and attributed to specific causes. Data collection for 1975 cones has been completed, but the results remain to be analyzed. This 2½-year study will be concluded after the cone harvest in 1976.

Caging Study. Cages were placed over cones and conelets on selected branches of loblolly seed orchard trees included in the impact study to protect them from seedbugs. The cones, which were protected during the second year of development, were harvested in October and analyzed in the same manner as the impact study cones. The seed yields of the uncaged cones from the impact study will be compared to the yields from caged cones to determine the extent of seedbug damage during the seed maturation period. New cages were placed over a portion of the previously caged conelets in October, 1975 to protect them from seedbugs throughout development until cone harvest in 1976. The seed yields in caged and uncaged cones will be compared to determine the extent of seedbug damage during each year of development.

Carbofuran (Furadan®) Tests. A cooperative southwide research project also was conducted in 1974 and 1975 to evaluate the effectiveness of carbofuran (Furadan ®) for the control of cone and seed insects in seed orchards. Carbofuran is a systemic insecticide which can be applied in granular form to the soil, where it is taken up by the roots and translocated throughout the tree.

In the spring and summer of 1974, carbofuran was applied in a wide variety of treatments to a total of 72 trees in the slash pine high-density seed orchard at Magnolia Springs.

The cones from the treated and untreated (check) trees were harvested separately and sorted to determine the percentage of cones damaged by coneworms and other causes. Six cones from each tree were then sent to the Southeastern Forest Experiment Station, Forestry Sciences Laboratory in Athens, Georgia where they were analyzed for seedbug damage. These tests also were conducted

Table 5. Results of the 1974 & 1975 Carbofuran Tests in East Texas Seed Orchards.

Treatment	Oz./inch DBH	Percent Cones With *Dioryctria* Damage	Percent Full Seeds	Percent Seedbug Damaged Seeds	Number Sound Seed/Cone
1974 Slash-Magnolia Springs					
Check	0	5.8	60.9	21.4	17.0
Carbofuran 10G	4	4.4	82.5	5.2	25.8
Carbofuran 10G	8	8.2	66.2	14.7	13.9
Carbofuran 10G	16	2.0	79.9	7.1	25.6
1975 Slash-Magnolia Springs					
Check	0	3.7	73.7	8.1	72.7
Carbofuran 10G	4	3.2	80.2	2.2	75.0
Carbofuran 10G	8	2.4	85.1	3.5	100.9
Carbofuran 10G	12	1.0	80.5	1.9	106.8
1975 Loblolly-Conroe					
Check	0	4.1	71.9	4.5	63.9
Carbofuran 10G	4	4.3	67.3	6.7	60.1
Carbofuran 10G	8	2.5	72.2	4.9	61.8
Carbofuran 10G	12	3.8	68.3	4.8	56.1

in nine other orchards throughout the South, and the overall results were promising enough to warrant repeating the test in 1975.

Thus, in the spring of 1975, the carbofuran screening tests were repeated on 24 trees in the same slash pine orchard at Magnolia Springs, as well as on 24 trees in the Conroe loblolly pine seed orchard. The cones harvested from the trees involved in these 2 tests were analyzed as in the 1974 carbofuran test.

Results of the 1974 and 1975 tests are similar (Table 5). The level of damage by *Dioryctria* coneworms was low throughout both orchards, and only a slight reduction of coneworm damage was observed in the cones from the treated trees as compared to the check trees. At Magnolia Springs, there was a significant reduction in seedbug damaged seed from treated trees in 1974 and 1975 at all 3 application rates, as compared to the seeds from the check trees. No significant differences in seedbug damage levels were observed among treatments in the Conroe seed orchard in 1975, perhaps because of low seedbug population levels.

Due to the effectiveness of the carbofuran tests as demonstrated throughout the South, efforts are now being made to register this insecticide with the Environmental Protection Agency for the commercial control of coneworms, seedworms and seedbugs in southern pine seed orchards. Also, improved methods of incorporating carbofuran into the soil currently are being developed and evaluated by other southern research agencies.

Fungi Associated with Loblolly Pine Seeds. Investigations on fungi associated with loblolly pine seeds and their effects on early seedling development were conducted from 1972-1975 as part of the cone and seed pest research project. Results of this study were used by Garland Mason as partial fulfillment of a Ph.D. degree at Texas A&M University.

A total of 61 fungi were isolated from loblolly pine conelets, cones, seeds and young seedlings, including one or more species of *Aspergillis, Alternaria, Chaetomium, Cladosporium, Curvularia, Epicoccum, Fusarium, Gilmaniella, Geotrichum, Hyalodendron, Pestalotia, Penicillium, Rhizopus, Syncephalastrum,* and *Trichothecium,* plus 22 unidentified isolates.

Pathogenicity was indicated for 16 of the 61 isolates in inoculation tests while germination of pine seeds was reduced by 8 isolates. Three isolates of *Fusarium moniliforme;* one each of *Geotrichium, Pestalotia* and *Trichothecium;* and one unidentified isolate were associated with high levels of seedling damping-off (50-100 percent of germinated seeds). Of the fungicides tested, benomyl, thiabendazole, and thiophanate most effectively suppressed fungus growth.

Phytotoxicity tests were conducted with seed treatments of benomyl, thiophanate, thiabendazole, and thiram at various concentrations. Of these fungicides, thiram and thiophanate had little or no adverse effect on seed germination at all treatment levels, while benomyl and thiabendazole caused moderate germination failure at 62.6 g/kg. of seeds and extreme phytotoxicity at 125.2 g/kg. Control experiments indicated that thiophanate maintained a good combination of seed germination and disease reduction at all treatment levels (1.25 to 125.2 g/kg of seeds). Benomyl was effective at 1.25 g, but phytotoxic at higher concentrations. Thiram did not effectively reduce seed-borne damping-off fungi at any level tested. Thiabendazole was also ineffective, with damping-off occurring at low levels and excessive seedling mortality at the higher levels.

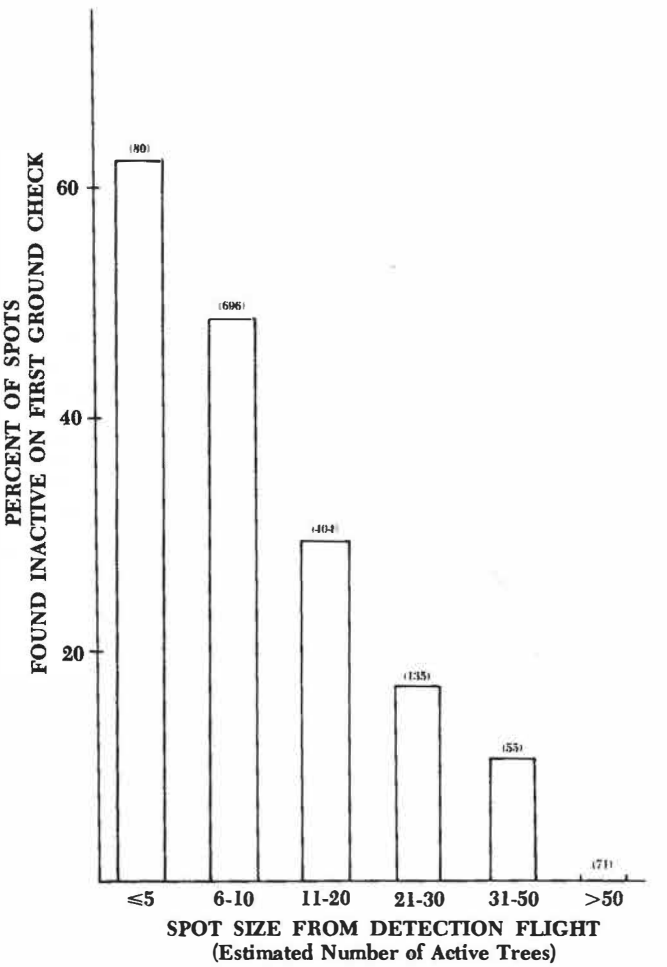


Figure 10. Relationship Between Number of Active Trees as Estimated From the Detection Flight and the Proportion of Spots Found to be Inactive When Ground Checked Within 30 Days of Detection (June-Dec., 1975). Numbers within parentheses represent the total number of spots per size class.

Southern Pine Beetle Research

Spot Proliferation Analysis. With the computerized data for 1973-1976 generated by the Operations Informational System, the Texas Forest Service is developing a methodology for evaluating the operational effectiveness of SPB control tactics. Briefly, a computer program was developed to measure the frequency with which new spots occurred within a fixed area of every controlled spot throughout East Texas. The test of treatment effectiveness was based on the proportion of controlled spots having one or more new spots (proliferation) detected within approximately 1/2 mile (605 acres) subsequent to the date of control. (For the purpose of this analysis, it is assumed that any new spot developing withing 1/2 mile was initiated by beetles escaping from the controlled spot).

The analysis of 1974-1975 records revealed low levels of proliferation associated with spots controlled by both "cut and leave" and salvage methods applied during the summer months (June to September). In contrast, higher levels of proliferation occurred about spots controlled during the winter (October-December), as well as about uncontrolled spots remaining active into the winter.

The preliminary results suggest that beetle dispersal and theinitiation of new spots is a seasonally dependent phenomenon, occurring primarily during October through May. Spot expansion (growth), caused by beetles attacking trees on the periphery of the spot from which they emerged, appears to be the most common mode of SPB infestation during the summer. Accordingly, summer control by either "cut and leave" or salvage appears to be effective for mechanically disrupting spot expansion as well as reducing the frequency of new spot proliferation. Analysis of the 1975-1976 operations data is now in progress to substantiate these conclusions.

Influence of Spot Size on Spot Inactivity. A substantial number of SPB spots either are inactive at the time of first ground check or go inactive soon thereafter, thus requiring no control action. For example, of all the spots detected during 1974 and 1975, the proportion of spots reported to be inactive consisted of 39 per cent and 33 per cent, respectively. From an operational standpoint, the ability to predict which spots are most apt to remain active would allow ground check and control crews to restrict their activities only to these spots.

Analysis of the operational records revealed a strong correlation between the number of active trees in a spot (as estimated from the air) and the tendency of that spot to go inactive. As shown in Figure 10, spots estimated from the air to contain 5 or fewer active trees had a 62 per cent probability of being inactive when first visited on the ground in 1975. This probability decreased abruptly as the estimated spot size increased. The same inverse relationship prevailed in 1973 and 1974.

Various factors influence whether or not a spot will remain active. However, the single parameter of estimated active trees provides a useful guideline for setting initial control priorities. For example, the fact that most spots containing less than 10 active trees tend to be inactive when ground checked provided the rationale for increasing the minimum spot size for detection purposes from 5 to 10 trees in 1974. Any small spot that is overlooked by one detection flight will be reported on a subsequent flight if that spot increases in size above the 10 tree limit. This decision alone has substantially reduced the workload of ground check crews, as most small, inactive spots no longer are detected.

Influence of Stand Factors on Spot Growth. Little is known about the factors which affect the rate at which SPB infestations expand, although tree size, stand density, and species diversity are believed to be important. All of the studies which have dealt with the interaction between stand characteristics and SPB infestations have attempted to identify factors which predispose individual stands to initial infestations. No study has dealt with stand factors which influence either the ensuing rate of spot growth or eventual spot inactivity.

In 1975, the Pest Control Section began to closely monitor selected spots to further characterize spot growth and inactivity patterns (Figure 11). Successful development of a mathematical model of spot growth, the ultimate goal of this study, would be valuable for several reasons. For instance, during the summer months in East Texas the number of spots detected exceeds control capability, creating a significant time lag between spot detection and control. Therefore, to better set control priorities, it would be desirable if a landowner could determine which of two or more active spots poses the greater hazard in terms of timber loss. Secondly, a spot growth model could be used to impress upon the landowner the benefit of prompt control by predicting how much timber he can expect to loose if no control is applied. Such a model also would aid in the development of a stand "hazard rating" based not only on spot occurrence, but on potential loss from spot expansion as well.

Preliminary results from the summer of 1975 indicate that the rate of SPB spot growth is not the same for all spots but varies predictably, depending on stand conditions. Of primary interest to the forest manager is the direct correlation between stand density and spot growth. In general, over-



stocked stands appear to represent a higher hazard in terms of potential loss than do stands of lower density. Therefore, reduction of stand density, all else being equal, should result in reduction of loss from spot growth. This study is being continued in 1976. The expected result is an empirical model for use by the forest manager in SPB pest management.

Seasonal Variation in the Southern Pine Beetle. In East Texas the SPB goes through an average of 7 generations per year. Depending on the time of the year, a generation may last as long as 3½ months or as short as 26 days. This varying length of the developmental period is known to influence both population survival and individual beetle characteristics.

As mentioned previously, the beetle's ability to fly long distances and to successfully initiate new infestations appears to vary with the season of the year. This seasonal variation may be due, in part, to changes in the general physiological condition of the insect resulting from different developmental rates of the brood. The fact that beetle populations change from one season to the next has important implications for both the timing of control and the recommendation of a control procedure.

For instance, a procedure such as "cut and leave" may cause a significant amount of beetle mortality during summer months by forcing weakened beetles to disperse out of an active infestation. These insects apparently have a low probability of establishing new infestations. On the other hand, if insects are forced to disperse when their physiological condition is optimal for flight (during late fall to late spring), then the probability of mortality through dispersal is lowered while the probability that they will establish new infestations (proliferations) is high.

Preliminary results of a study initiated in 1975 show that there are indeed seasonal changes both in the size and physiological condition of the insect. Beetles reared from trees attacked in July and August were of much smaller size and had significantly lower fat contents than did beetles emerging in the fall, winter or spring. A lower fat content is an indication that summer-reared beetles have a smaller energy reserve available to permit long distance flights. This study is being continued in 1976.

In combination, the SPB research studies now in progress are expected to contribute to improved recommendations for the application and timing of specific control techniques and, in the long run, should provide a scientific basis for the establishment of silvicultural regimes for preventing future beetle outbreaks.

Feasibility of Salvaging Small SPB Spots. From June through December, 1974, the Texas Forest Service conducted a special project in District 6 (Conroe) to determine the economic feasibility of salvaging small SPB spots that are generally avoided by commercial salvage operators. A John Deere 350 crawler tractor (Figure 12) was leased for six months at a total cost of $8,310 and used to salvage a total of 12 spots in Montgomery and adjoining counties. The 5-man crew initially used for the salvage operation was reduced to 3½ men later in the season to reduce operational costs. The average volumes salvaged were 20.9 cords from pure pulpwood spots and 14.7 cords and 8,403 board feet from pulpwood/sawtimber spots. All active trees were felled, and merchantable timber was skidded with the tractor to the nearest road to be taken to the mill by a contracted hauler. The average skidding distance per spot ranged from 150 to 600 yards. The landowner was paid a stumpage price of $2.00 per cord for pulpwood and $20.00 per MBF for sawtimber.

Although a small number of spots was salvaged during the six month period, the study served to identify some of the major factors which limit salvage as a control tactic for small spots: 1) current market price for salvaged timber, 2) cost of salvage equipment, 3) size of timber, 4) skidding distance, and 5) soil conditions.

Using $1.00 per tree as the estimated cost to apply the alternative method of SPB control "cut and leave," it was concluded that a salvage operation with the JD 350 tractor may be profitable only if market conditions equalled or exceeded $10.00 per cord for pulpwood and $45.00 per MBF for sawtimber *and* a skidder was purchased for use over a 10-year period to avoid the high cost of leasing. The total cost per cord to salvage a spot generally was found to decrease as the proportion of sawtimber increased and the skidding distance decreased. Poor ground conditions tended to increase salvage costs.

In summary, this study emphasized the fact that seldom can all SPB spots be economically controlled by salvage. Particularly when factors such as low market prices, small-sized timber, inaccessibility and poor ground conditions prevail (as they have in recent years), an alternative such as "cut and leave" often may be more practical.

Figure 11. Among the SPB infestations monitored periodically by the Pest Control staff in 1975 was one in this young pine plantation near Buna. Stand factors were measured and correlated with the rate and extent of spot expansion. Each tree marked with flagging had been killed by SPB.

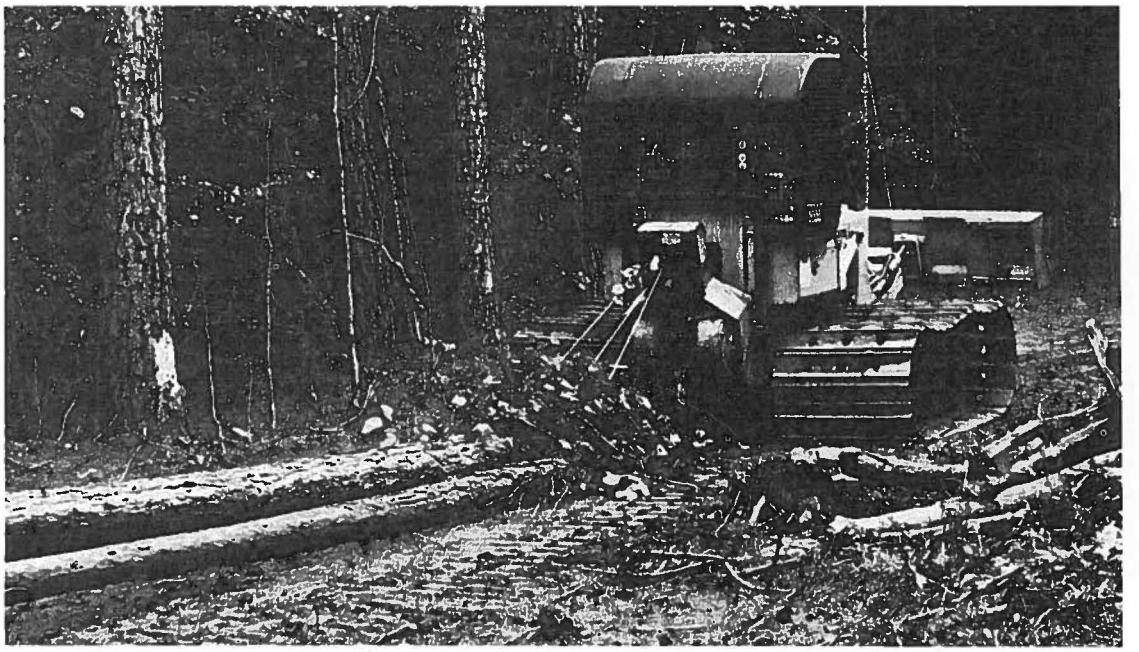


Figure 12. This JD 350 crawler tractor was used in a study to determine the economic feasibility of salvaging low volume southern pine beetle infestations in District 6 (Conroe). Note the wide tracks which allowed skidding over wet terrain.

Southern Forest Research Institute

The Southern Forest Research Institute was organized in 1963 by a group of private landowners of East Texas to seek new ways of coping with the increasing SPB problem. Through a contract with the Boyce Thompson Institute for Plant Research, entomologists under the direction of Dr. J. P. Vité conducted field-oriented studies for 11 years at the research station near Sour Lake. Among the more significant contributions of this effort were: 1) the clarification of SPB aggregation behavior and attack dynamics within stands, 2) the isolation and identification of frontalin, the primary aggregation pheromone of SPB (as well as the identification of several *Ips* pheromones), 3) the artificial manipulation of SPB populations, 4) identification of factors affecting the susceptibility of southern pines to bark beetle attack, 5) the development of several control tactics based on SPB response behavior (frontalure and cacodylic acid) or limitations in brood development (cut and leave, cut and top).

In September, 1974, the Boyce Thompson Institute discontinued studies on the southern pine beetle and SFRI was disbanded. Although the SPB still remains a problem in East Texas, the SFRI effort provided major achievements that have added substantially to our present knowledge of SPB and provide a foundation for present research efforts.

Dr. Vité, who is now with Frieburg University in West Germany, and the many other investigators that have contributed to the SFRI program over the years are to be commended for their pioneering research concerning a very complex pest problem.

Expanded Southern Pine Beetle Research And Applications Program

In response to the recent increase in SPB activity across the South, a five-year research and applications program was planned and implemented by two U.S. Department of Agriculture agencies — the Forest Service and the Cooperative State Research Service — in the spring of 1975. Several other federal and state forestry agencies, universities, and private organizations have joined in the effort to develop new or improved forest and pest management systems that will effectively suppress or prevent outbreaks of SPB. During the first year of this intensified program, 48 research proposals were selected and funded, spanning a broad array of activities. Fields of major investigation include the determination of impacts of infestation on multiple forest resources; sampling and predicting beetle population trends; site, tree, and stand characteristics affecting susceptibility to attack; critical factors affecting beetle survival; the identification and use of behavioral chemicals; the screening and evaluation of promising toxicants; and the identification and evaluation of forest practices affecting stand susceptibility.

Of the current research on SPB being conducted by the Texas Forest Service, the spot proliferation analysis is funded, in part, by this program.

Publications

Several publications concerning forest pests were issued recently by the Texas Forest Service or represent studies that were conducted in cooperation with the Service. These include the following:

1. "Salvage — The Preferred Method to Reduce Losses by the Southern Pine Beetle." Texas Forest Service Circular 225. 1976.

   This illustrated circular describes recommended procedures for controlling SPB spots by salvage and prompt utilization; includes a glossary of terms relating to SPB.

2. "Cut and Leave — A Method to Reduce Losses from the Southern Pine Beetle." Texas Forest Service Circular 223. 1975.

   This circular provides illustrated guidelines for application of the cut and leave tactic designed to control SPB by disrupting spot growth; also includes a glossary of relevant terms.

3. Hernandez Paz, Manuel. 1975. "El gorgojo de la corteza, plaga principal de los pinares." (The southern pine beetle — principal pest of Honduras pine forests). Corporación Hondureña de Desarrollo Forestal. Publicación No. 1, 13 p.

   This booklet, printed in Spanish, describes the life cycle, attack characteristics, parasites and predators, pheromone systems and methods for controlling the southern pine beetle. Illustrated with color pictures, this publication was prepared at the request of the Honduran Forestry Commission for distribution and use within Honduras, where SPB is a major pest).

4. Vité, J. P., R. L. Hedden and K. Mori. 1976. *Ips grandicollis:* field response to the optically pure pheromone. Naturwissenschaften 63:43.

   This article describes field tests which document that the five-spined engraver beetle, *Ips grandicollis* aggregates only in response to the (S)−(−)− isomer of the male produced pheromone ipsenol; the (R)−(+)− isomer proved nearly inactive while a mixture of the two optical isomers attracted intermediate numbers of bettles. The implications of these findings are discussed.

5. Vité, J. P., P. R. Hughes and J. A. A. Renwick. 1976. Southern pine beetle: effect of aerial pheromone saturation on orientation. Naturwissenschaften 63:44.

   An aerial application of "Frontalure," a mixture of the attractant pheromone frontalin and the host terpene *a*-pinene, was conducted in an attempt to disrupt aggregation behavior of SPB within an infestation. Results proved unsuccessful as the saturation with synthetic pheromone caused a rapid increase in the aggregation of beetles on pine trees undergoing attack, rather than the decrease originally expected.

6. Texas Forest Service. 1975. "On the trail of the elusive southern pine beetle: TFS Operations Informational System." Texas Forest News Vol. 54:6-10.

   An article describing the southern pine beetle and how the Operations Informational System functions to aid owner notification, ground check, and control operations.

7. Mason, G. N. 1975. Fungi associated with *Pinus taeda* L. seeds and effects on early seedling development. Ph.D. Dissertation. Texas A&M University. 155 p. (See Section on Cone and Seed Pest Research for abstract).

Pest Control Staff

At present, the Forest Pest Control staff consists of the following members:

Dr. Ronald F. Billings — Principal Entomologist
Dr. Roy L. Hedden — Entomologist III
Mr. Herbert A. Pase III — Entomologist II
Mr. R. Scott Cameron — Entomologist I
Mr. Charles A. Kibbe — Forester
Mrs. Eva P. Fagala — Technician I
Mr. F. Alan Smith — Aide to Specialist
Mr. Rick W. Tucker — Seasonal Assistant
Mrs. Martha L. Johnson — Clerk II

A number of staff changes occurred in the Pest Control Section during 1975. Garland Mason, a member of the Section staff since 1967, completed a Ph.D. in forest pathology at Texas A&M University and left the Texas Forest Service to become assistant professor of photogrammetry at Stephen F. Austin State University School of Forestry.

Brief biographical sketches of the new professional staff members who joined the Section in 1975 are presented below:

Dr. Roy L. Hedden

Roy, a native of Washington, has a Bachelor's degree in forest science, a M.S. and a Ph.D. in forest entomology, each from the University of Washington in Seattle. His specialty is bark beetle pheromones, but he also is well versed in biological statistics. As entomologist with the Boyce Thompson Institute during 1973 and 1974, he supervised field research on Douglas-fir beetle pheromones in Idaho. Since joining the staff in April, 1975, Roy has initiated research on southern pine beetle spot growth phenomena, beetle pheromones and seasonal variation in population quality.

Mr. R. Scott Cameron

Scott, born in Upland, California, joined the Section in late April, 1975. He has a B.S. degree in forest management from Utah State University, and a M.S. degree in economic entomology from Cornell University. From 1970 to 1975, he served with the U. S. Peace Corps as professor of forest entomology at Austral University in Chile. His field experience includes assistance with research on rust diseases of pine, cerambycid pests of Chilean hardwood trees and biological and chemical control studies on the annual bluegrass weevil. Since September, Scott has assumed responsibility for the research program on seed orchard insects and diseases formerly directed by Garland Mason.

Mr. Charles A. Kibbe

Charles, a native of Texas, received his B.S. degree in forest management from Stephen F. Austin State University in 1975. He joined the Section as a seasonal assistant in June, 1975 and assumed the permanent position of Forester in September. Charles primarily assists Dr. Roy Hedden in field research on the southern pine beetle, but also aids other on-going projects in the Section.

Appendix I. County Summary of 1974 SPB Spot Infestations.

County	Spots Detected	Spots Controlled	Spots Inactive	Spots Outstanding*
Montgomery	641	328	271	42
Walker	518	236	225	57
Angelina	377	148	185	44
Hardin	340	171	89	80
Liberty	311	154	105	52
Houston	290	124	116	50
Trinity	257	101	126	30
Jasper	235	111	50	74
Polk	202	144	51	7
Tyler	151	61	81	9
Cherokee	133	77	50	6
San Augustine	127	30	43	54
Nacogdoches	118	44	66	8
Newton	111	66	15	30
San Jacinto	82	42	29	11
Grimes	76	28	43	5
Anderson	65	52	11	2
Harris	55	19	32	4
Sabine	53	19	27	7
Rusk	45	26	17	2
Orange	31	19	5	7
Shelby	23	8	10	5
Panola	16	5	11	0
Jefferson	12	2	6	4
Waller	10	6	4	0

*Require ground check or control action at end of year.

Appendix II. County Summary of 1975 SPB Spot Infestations.

County	Spots Detected	Spots Controlled	Spots Inactive	Spots Outstanding*
Hardin	732+**	441	179	112
Liberty	570+	253	157	160
Jasper	433+	206	136	91
Polk	325+	279	30	16
San Jacinto	281+	100	82	99
Angelina	269−	149	73	47
Montgomery	266−	75	170	21
Tyler	245+	134	95	16
Houston	212−	124	88	0
Trinity	183−	87	90	6
Newton	175+	95	48	32
Walker	173−	53	116	4
Orange	149+	58	53	38
Nacogdoches	128+	85	29	14
Shelby	127+	116	11	0
Cherokee	124−	58	64	2
Sabine	110+	57	35	18
San Augustine	84−	21	31	32
Harris	59+	26	15	18
Anderson	56−	35	15	6
Jefferson	45+	10	14	21
Grimes	42−	17	24	1
Rusk	41−	21	18	2
Panola	29+	11	18	0
Chambers***	27+	3	8	16
Waller	15+	7	8	0
Harrison***	9+	5	4	0
Upshur***	1+	0	1	0

*Require ground check or control action at end of year.
**+ or − indicates increase or decrease from 1974.
***County uninfested in 1974.